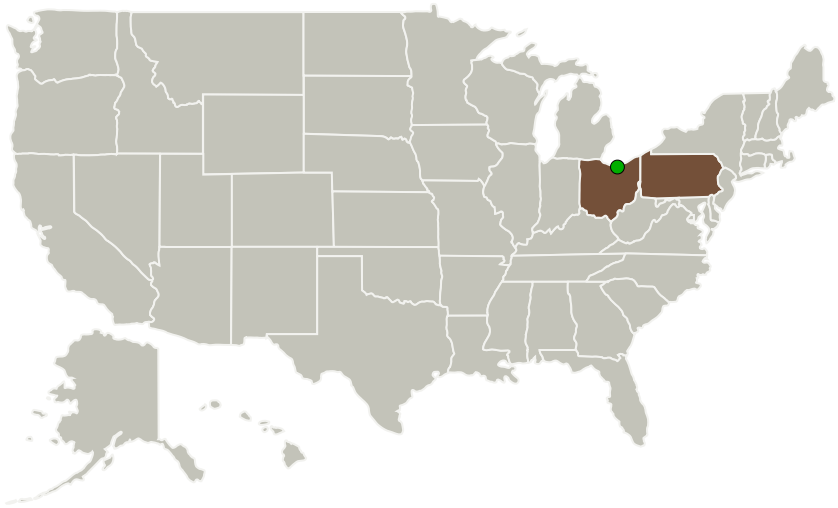
A Generalized Software Toolkit for Portable GPU-Enabled Chemistry Acceleration in CFD Applications, Phase I

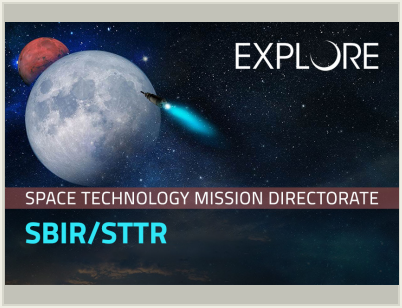
Completed Technology Project (2011 - 2011)

Project Introduction

Current combustor design simulations aimed at reducing greenhouse gas emissions and improving fuel-lean combustion have entailed using large amounts of dedicated CPU resources for extended time periods due to the expense of solving detailed, strongly-coupled, chemical kinetic models. Such models are inherently data parallel, and much faster solutions can be obtained using low-cost graphics processing unit (GPU) hardware without loss of accuracy. This proposal describes development of a user-friendly software toolkit that facilitates implementing detailed or reduced fuel chemistry solvers directly onto GPUs to substantially accelerate CFD simulation runtimes. The approach is significant because it provides a cost-effective path to substantially reduce the wall-clock times currently bottlenecking high-fidelity combustion simulations. It accommodates the incorporation of self-contained, real fuel kinetic mechanisms and validated chemistry solvers, written using standard GPU-recognized program language extensions such as CUDA and OpenCL, for use in CFD analyses with minimal end-user code modifications. Using inputs that are Chemkin-format compatible, the proposed software toolkit will generate portable, GPU-enabled kernels that can be directly compiled into existing CFD codes, such as the National Combustion Code (NCC), to accelerate detailed combustion simulations for improved design support.

Primary U.S. Work Locations and Key Partners





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Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
CRAFT Tech - Combustion Research and Flow Technology	Lead Organization	Industry	Pipersville, Pennsylvania
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Ohio	Pennsylvania

Project Transitions

February 2011: Project Start

September 2011: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137817)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CRAFT Tech - Combustion Research and Flow Technology

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

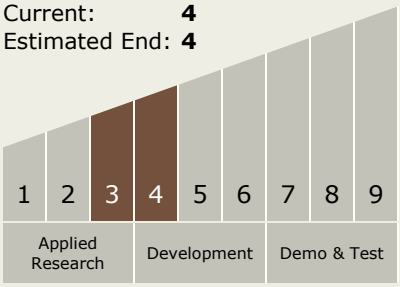
Carlos Torrez

Principal Investigator:

Andrea Zambon

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.3 Aero Propulsion
    - TX01.3.12 Alternative Low Carbon Jet Fuel

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System